TOWN TRANSIT—THE AIR LINE.

We have had propositions of various kinds to facilitate passenger traffic in our streets—railways on the street-level—railways below the streets—and railways over the house-tops. We have, moreover, the electric telegraph, supposed to dispense with both letters and persons in the way of communicating intelligence. But, strange to say, even the telegraph people themselves, in the dispatch of their own business, found that their public scheme of word-transit would not answer their private purpose. So they revived on a small scale the proposition of the engineer Vallance, for a tube to carry passengers between London and Brighton by means of air pressure, but substituting the natural pressure of air behind by an exhaust in front, instead of direct pressure by mechanism behind. "Better lead than drive," is an old proverb, and the air and the donkey are alike in this respect, for the air sets up a great resistance to being *forced* through a tube, but is very amenable to suction.

Coleridge, in the "Ancient Mariner," asks,

> Why drives on that ship so fast,
> Without or wave or wind?

And the answer given is—

> The air is cut away before,
> And closes from behind.

With all due submission to the poet, there was no marvel in this case; it was wind—and nothing but wind—caused by the air rushing to supply the vacuum.

The electric people laid down, from one office to another, a lead pipe some two inches in diameter, with an air-pump attached at the delivery end. The pipe passed downwards under the street, up again, and the open end curled over the office desk. A short cartridge-looking case with an opening at the side, to contain a roll of paper, being put into the pipe, and the pump set to work to exhaust in front of it, created sufficient vacuum to cause a rush of air and wind behind, and propel the cartridge like a bullet through a gun-barrel till it fell out on the desk where it was wanted.

To do this on a larger scale simply needed a larger pump or exhaust. But people did not contemplate a tube large enough for passengers, and so Mr. Clegg devised a method of driving a piston in a long pipe with a side slit to connect the piston with a train of carriages, closing it with a leathern valve and a coating of waxen salve. This was put in practice on a steep curving line of railway called the Dalkey, about a mile in length, joining the Dublin and Kingstown. A single carriage worked in this way brought passengers on to the line and took them to the top of a breezy hill by this kind of air-rope, which did not pay by itself, but served as an attraction to make the main line pay. The late Mr. Brunel was encouraged by this to make the South Devon line full of steeps and curves, and applied the system, but it failed at a great loss to the shareholders. It was again tried on the Croydon line, and again failed. The leakage at the long side-valve was fatal. Had the poet stood by the side of it, he would have found that the cutting the air away before did indeed cause a "rush," not merely behind, but sideways. It would have pulled in a truss of straw, had there been room, or a dog's leg, or a small child, or any moveable lying at hand, not too large or too heavy. It would have carried off every note in the Bank of England—both "stiff" and "flimsy"—and tried hard at the "blunt." But the pumps had to work so hard to keep down the leak that it would not pay, and so, one fine morning, the manager caused the whole of the pipes to be pulled up and the pumps to be pulled down, and there was an end of it.

It has been revived again by Mr. Rammell, under the name of the Pneumatic Dispatch. He has got together a company with men in it who have known something of business—the Marquis of Chandos and Captain Huish, so long on the North-Western Line, and a sample has been laid down at Battersea. But in this case the vehicles are put inside the tube, which is thirty inches in diameter, and so form the piston.

The tubes are of cast iron, and are laid with ascents and descents of one in twenty-two and one in twenty-five, and with very sharp curves. The exhaust is produced by a fan of large diameter. When nearly at the end the carriages are turned by the rails into a separate tube with atmospheric air in it, which is compressed by the momentum, and forms a buffer. Just at the time the carriages stop, they touch a trigger, which throws open the door at the end of the tube, and then the carriages run out into the open air.

Without at present entering into the cost of power, there is no doubt that the plan is effective, and effective under very unfavourable circumstances of trial, the friction being far greater than is needed, and the fit of the vehicle in the tube being far from so accurate as it might be. Moreover the test in a small tube is much more severe than in a large one.

The pressure obtained was about 40 lbs. to the square foot, and the area is about five square feet; the speed was about fifteen miles per hour.

With this arrangement transit over the house-tops becomes practicable. A tube of wrought iron plate to carry a carriage eight feet square, or sixty-four square feet of section, might be constructed, weighing about 12 cwt. per yard, run, at a cost of about 12,000*l*. per mile, and this tube might be glazed with small pieces of plate glass, so as to give ample light. A carriage carrying 50 passengers would weigh about 3 cwt. per foot run, or a total of 4½ tons. Thus 200

passengers on a train over a street of 120 feet wide, would only be 18 tons, or one-third the weight of a large locomotive and tender, and the power required to draw it on the level would only be about 250 lbs., or 4 lbs. per foot of area. At a maximum pressure of 40 lbs. per foot a train of 1200 passengers might be taken.

The advantages of such a system would be easy and sheltered, yet light, transit, with perfect ventilation and freedom from dust, smoke, or vapour. The disadvantages would be "such a getting up-stairs." But this might be alleviated by mechanical lifts, performed by the same engines used to obtain the vacuums. Whether the houses would be strong enough to carry the load, and whether the owners would demand too much rent, are other questions. The question of noise does not raise a difficulty, for the movement might be almost noiseless. The safety would be absolute. There would neither be engines to explode or run into trains a-head, nor trains to get off the line.

It is a question of cost, but it would be difficult to make it cost so much as portions of the Blackwall line.

Anyhow, the air line is as much a practical thing as the telegraph over the house-tops, and only a question of cost and ownership.

And, if an underground line is a necessity, the iron tube air-worked is the only plan of wholesome transit.

W. BRIDGES ADAMS.

AËRIFORM SEWAGE AND CAPTAIN LIERNUR'S SYSTEM.

OUR modern system of dealing with excreta in towns very closely resembles the practice of our savage ancestors. Ancient towns were very commonly situated on streams and rivers for the convenience of water supply, and also of transit, together with the advantage of fishing. And nothing

would be simpler and easier in dealing with excreta than tumbling them into the stream to be washed away from their doors and consumed by fish. The ancient Lacustrian people were peculiarly happy in this arrangement, and it answered very well so long as the inhabitants were not numerous. Our variation on their practice consists chiefly in making underground holes to convey the sewage to the streams. One of our modern sewage doctors once witnessed the washing out of a mass of dirt from a water reservoir by a stream from the pumping-engine, and after calculating the hours of labour which it would have taken to do it by hand, proclaimed far and near that "Water is your only cheap carrier." He forgot the water had carried the dirt into the reservoir as well as out, and so he urged the increased use of water; and having been told by Smith of Deanston of the wonder-working "foul burn" of Edinburgh and its green crops, he thereupon concocted a theory that all sewage should be diluted to an unlimited extent—the more the better—and that this 100,000th dilution should be flooded on to the land. All the lore of Liebig was pressed into his service, cesspools were denounced, and sewers required to be thoroughly washed out.

And so the river was flooded with sewage, which deposited its solid matters on every shore and bank, to be stirred up and churned by every paddle that passed. So long as the weather was cool, this did not signify much; but with summer's heat, acetous, and then putrid, fermentation set in, with a stench that found out the legislators in their Westminster Palace, and induced them to commit the sewers to the charge of the Board of Works. Now, one advantage in the river arrangement was, that the various gases evolved during the heat rapidly escaped into the upper atmosphere to be neutralised, and when the heat ceased the gases ceased to be produced. But when the Board of Works closed the sewers to the river, and confined the sewage to their large new brick tubes, they provided a perennial summer atmosphere, to keep the fermentation constantly going, and as dirty gas runs up hill while dirty water runs down hill, the streets and houses now get constantly flooded with noxious vapour, which in many cases forces its way with strong pressure through water, and forms a gilded puddle on the surface of the water traps. And so long as this system continues the only existing remedy is to build tall chimneys like those of manufacturing towns at every half-mile along the course of the sewers. And this the Board of Works will put off as long as possible, because it would be a practical acknowledgment that they had not been foreseeing, and had to amend an error in their programme. The egotism of individuals is bad enough, but the egotism of Boards is insuperable. They would fain appear infallible, and to acknowledge an error, is to proclaim that they also are but men. The truths of nature are to them demonstrable fallacies when their infallibility is called in question.

The present writer has always considered the carriage of sewage in water a fallacy, and has frequently pointed it out. Many common-sense people have arrived at the same conclusion, and one of more than common sense had arrived at the same conviction in ages long past, when he enjoined on every man in the Israelitish camp to have a paddle or spade on the end of his spear. The Reverend Mr. Moule of Dorchester has been advocating the use of earth closets in opposition to water; and he is right so far, though the structure of buildings in this great city is not well adapted for carrying away the mass of refuse. One valuable quality this system has—the prevention of fermentation, which is the great source of nuisance. And this fermentative or putrefactive process carries off a large portion of what is valuable as manure. If fermentation were carried on to exhaustion, the residue would be scarcely of any value.

Sewage is compounded of many substances, animal and vegetable, together with the refuse of living bodies; but none of these are noxious till putrefaction begins, and the great element for inducing putrefaction is water. If the substances be dried no putrefaction takes place, a fact long known to manure manufacturers; and the old cesspits were theoretically better than the modern sewers, inasmuch as they were not supplied artificially with a mass of water, the solid matter sinking to the bottom, and the liquid running away; not a desirable condition of things, because percolation through the earth conveyed poison to the water springs.

Decaying vegetables and the refuse of stable-yards are easily handled, and are carted away because they are of sufficient value to pay for the labour; so are decaying flesh and bones. Were they not of value, there would be one obvious mode of dealing with them—carrying them to the gas-works and burning them under or in the retorts. So also might solid fæcal matter be treated, for it would make good gas, as well as animal charcoal—a very valuable product. But how to obtain it solid without considerable cost in preparation is the difficulty.

Every day is brought into this huge city, in addition to permanent materials, fuel and

food, both solid and liquid, for the purposes of consumption, and they are brought chiefly by wheeled vehicles, water carriage being but a small part, save in the case of coal and water. All these things are by the processes of burning and digestion reduced to a very small comparative bulk and weight, save only the water, which remains the same. The ashes remaining from a burned ton of coal are very small, comparatively, both in bulk and weight, and the average solid refuse from human bodies is but one quarter of a pound each average person per day, or 335 tons per day, equal to 547 cubic yards in bulk, for the whole of London. The fluids from the same source average one pound and a half daily, or 2000 tons per day, equal to 562,500 gallons, or 5207 butts, about 3280 cubic yards in bulk.

These two substances, then, are the real source of sewage nuisance, the solid forming in volume a cube of 1½ feet, and the fluid a cube of about 9 feet per annum each person: total, 10½ cubic feet.

The dry ashes of the coals thoroughly mixed with the drained solids would perfectly neutralise them and render them innoxious, and fit for manuring clay lands and corn land. The coal-ashes in any case must be conveyed away, and the solid fæcal matter added to them would not appreciably enhance the cost. The fluids might be run into close reservoirs, and pumped into barrels for transport, and, freed from the bulk of water now used, the cost of conveyance would become a minimum.

In the olden time the practice was to have a cesspool large enough for the accumulation of seven or ten years. In Paris it extended to half a century. During all this time the valuable portions disappeared in gases more or less noxious, whenever the surface temperature was sufficiently high. Now, inasmuch as fermentation does not usually set in till the fourth day after deposit, it follows that, if the deposits were taken away day by day, or night by night, in the same proportions as the fuel and food which are their basis are brought in, there would be no nuisance or waste.

But to do this with the present structure of London dwellings seems almost an impossibility. To have as pleasant and convenient a room as possible to sit in was always considered to be more or less a necessity; something very inferior was considered quite good enough to sleep in; the provision safe and pantry needed something of light, and facile access, and absolute necessity enforced some provision for ventilation. The wine-cellar also was, perforce, dry and tolerably warm, and accessible under lock and key; but the names dust-*hole* and coal-*hole* clearly imply that any dark cranny was considered good enough for them, the space under the lower stair, even in decent houses, being their locality, ere the invention of cellars under the pavements. The refuse of food, it was thought, might be put away in any dark corner.

It is a maxim with all good housewives to have no dark corners about a house—"slut-holes," as they were anciently termed; and it will be only when every portion of the house, both for the fresh provisions and the consumed provisions, are equally accessible to air and light, and open to examination, that the evil will be remedied. This means the alteration of most of the houses in London. Rich people, who keep carriages and horses, would think it very objectionable to have all their stable manure carried through the hall-door, and so their houses are commonly built back to back, with a mews between them, and nothing can well be neater than the mode in which the refuse litter and stable manure is piled up each day in the open air, ready for carrying away. It is not thought advisable to keep this in a dark hole; and, consequently, being before people's eyes, there is no neglect in carrying it away before it begins to ferment.

These difficulties, having been under the consideration of Captain Liernur, an engineer of Holland, have led him to devise a new system for the conversion of the present water-butts into air-closets. It has long been a practice in various cities on the Continent to empty cesspools by means of a vacuum chamber carried on a waggon. The vacuum is produced, either by an air-pump or by an injection of steam, or by burning spirits in the chamber. A metal pipe, with a stop-cock, leads from the chamber to nearly the bottom of the cesspool, connected by a hose. The vacuum being complete, and the stop-cock opened, the matter rushes up and fills the chamber without any need of hands; but this plan can only be available for a large mass of matter—six or twelve months' collection, with nuisance during the period, unless mixed with earth, or coal-dust, or other absorbent material, which would render it impracticable to empty it by the hose and vacuum, the Captain's plan is to empty every receptacle nightly.

The principle consists in discharging the fluids and solids through a large opening without a bottom, or valve, so that they may fall into a vertical pipe of cast iron, forming a curve, or syphon in the ground, both ends of the pipe being open, the upper one above the house roof and the other in the drain-pipe in the centre of the streets where they intersect each other. At the intersection is placed, under ground, an air-tight wrought-iron vessel, some five feet in diameter and three feet in

height, and this vessel receives four drain-pipes from the streets. A stand pipe from this reaches nearly to the bottom, and rises to the level of the street. The whole system is air-tight. A portable or traction engine is run over the opening of this pipe, and a vacuum is formed by an air-pump worked by the engine. Air-valves are then opened in succession to every house connected with the cistern, and the atmospheric pressure drives both fluids and solids out of the closet pipes into the cistern. From this the exhaust carries it into a close barrel, or tank, on the engine, and it is taken away to a railway station, or wharf, where it is discharged into barrels by a similar process for transport to cultivated lands, the dwellers in the houses knowing nothing of it save that they have no fermented gases, and that the whole of the closets are swept out every night by a strong current of wind, while there is no valve to pay for, or leaky pipes to overflow. The whole of the pipes are of one diameter, about five inches, and there is therefore nothing to stop the free passage of anything that gets into them. The details have all been carefully considered by Captain Lienen, and experience seems to prove that the fæcal matter does not induce rust inside the pipes, but rather sheathes them, so that only the outsides need special guarding against rust. Captain Liernur, who is a member of the Royal Institution of Engineers of the Netherlands, is now engaged, in conjunction with Mr. Petersen, the City Engineer, in applying this system to a special district of the Hague, where the low level renders any ordinary system of sewage impracticable.

To bring any new system into use, requires the setting of a careful pattern in successful work. Now this plan is especially adapted for division into localities independent of each other. It is, therefore, particularly worthy the attention of builders engaged in new localities erecting squares of buildings, or villas, where main drainage does not exist and even the ordinary water supply depends on wells. For the larger country dwellings of noblemen and gentlemen, where a fixed or portable steam-engine is at hand, every drain may be rendered perfectly free from gases. The whole system is independent of levels.

Towns situated on the seaside cannot possibly be made wholesome by a system of water-closets discharging into the beach or into the sea, and becoming a nuisance to bathers; but upon this system they may be wholly freed from nuisance, and without dealing with the enormous volume of dilution required in the water-closet system.

Captain Liernur's calculation is, that one steam-engine of from 10 to 12 horse-power, such as are now common in agricultural districts, with three tenders each of 90 cubic feet capacity, with about half a dozen men working from seven to eight hours nightly, could dispose of the excreta of 10,000 inhabitants, say 1,000 houses, in a concrete form, unmixed with water, and weighing about six tons. At this rate it would need 300 steam-engines and a corps of 2,000 labourers to keep all London cleansed, supposing it effective; but it would be really cleansed, and free from gaseous poison. And the manure, of the value of which we have heard so much, and of which we know that in Belgium it exceeds ten shillings per head, is put into a saleable form, which every farmer can recognise and appreciate. But the first thing is to get rid of a nuisance, the next to make a profit of it if we can; though we must not assume that the excreta are of equal value in all cases. Rich manufacturing cities yield more than agricultural towns, and Roman Catholic towns less than Protestant, for the reason that the value of the manure depends on the quality of the food that is eaten, and the surplus which remains.

It is quite clear that the success of the plan must depend on the sufficiency of fluid to keep the pipes clean and prevent their choking by the material. Contact should therefore be prevented except at the ground level, where the fluid lies, as in an ordinary cesspool, with the difference that the cesspool is only five or six inches in diameter and the whole contents are removed nightly. W. Bridges Adams.

RAILWAY RISKS.

HORSE FEET AND ROAD—ENGINE FEET AND RAILS.

Some years back, a man of a studious habit of mind looked in at the door of a veterinary establishment where a horse was undergoing a curious process called "firing," that is, the application of heat along the course of the tendons leading to the feet. Desirous of learning what it was for, he applied to a bullet-headed man in a sleeved waistcoat, who had just made a speech indicative of considerable humanity to horses, by way of reproof to a subordinate, "Is that the way to treat an oss, ye hass you?"

Thus delivered of his indignation, he turned to his questioner. "Ye see, sir, as how an oss in his natteral state can gallop over the turf for ever and ever, and never hurt hisself, and doesn't want no shoes neither. But ven the poor hannimal is put on to these here Lon'on roads, and, wus still, these here pavements, it stands to reason that if he hadn't no shoes he'd soon wear off his hoofs; and then with a load of iron, at a sharp trot, don't his poor feet come down like sledge-hammers, neither? If it wasn't for his natteral springs in his legs and feet, Lor' bless ye he'd be clean done up in a month. But, anyhow, his springs gets vored out and dummied like, ven he's been two or three years on the stones, and he hasn't no more feelin' in his feet than that fellow I've been a blowin' up, has in his head. So ven an oss gets so, he's groggy like, and doesn't know how to put one foot properly before the other, and he'd pretty soon be goin' down to prayers. So then they sets to, to fire his legs, and that brings back his feelin' like, and he's more safe again."

"In short, they re-harden and temper his leg-springs?"

"Eggzackerly, sir! But not to say as how they are ever so good as new, ven he'd only turf to gallop over, and not granite."

Time passed, and our student one day rested at a level crossing by the side of a railway, while train after train passed at high speed.

"Whence arises this thunderous sound, and whence this semi-earthquake?" were the reflections of our student.

Alternate contact and non-contact between the wheels and the rails, multiplied in effect by the speed, and resulting in heavy blows. There was no other solution. The wheels did not roll—they jumped. Rolling would be a continuous pressure only: jumping caused percussion; percussion caused noise.

"What caused the jumping?" was his next thought. Impediments by irregularity of the rails, and sledging movement instead of rolling movement of the wheels.

What, then, was the remedy? First to make the rails smooth and even, and bed them continuously in non-deflecting timber, and then to make the wheels like a horse's foot: to apply elastic resilience as near as possible to the rail.

And so the student became an inventor. Friends advised him not to pursue so unremunerative a path, but it was a "labour of love," and so he persevered. "Eureka!" he exclaimed one day, after calculations and experiments without end, which resulted in a system of rail thoroughly new, and which was universally scoffed at. "Eureka!" he exclaimed a second time, when he produced a wheel to match the rail, and which he called a "horse-foot wheel."

The mechanism was achieved and material difficulty surmounted, but the engineering of men's minds was a far less easy matter. The inventor could not get listened to. He could not, like the Ancient Mariner, find

> The man that must hear me.

So he tried an assemblage of many men, and wrote a paper which was read or sung before the British Association, which then held their sederunt in Glasgow; and then it was laid on the table, or under the table, and men knew it no more.

Still the inventor had faith in himself, and worked on. He became a peripatetic besieger of men about railways, who, like the Roman Centurion, had power to say "Go, and he goeth;" but none of them said to the inventor, "Come!"

But one day he fell in with a man in railway authority with whom he had formerly had a long dispute. He showed him drawings of both wheel and rail. After examination of both, the authority said, "I like the wheel; but the rail will not do at all: it will break down in a week."

"I am certain to the contrary," said the inventor.

"Well, then, I will try both! and more, I will try anything you say will do, simply because you say it, if not involving much expense."

Some time elapsed before the work could be put in hand. The rail excited mirth amongst the officials. A fortnight was the utmost that prediction would allow for its durability; but days, weeks, and months passed, and it became a marvel to all concerned. For three years the small sample was under trial, and then the engineer of a neighbouring line was induced to try it also. A third engineer laid down two miles; and a fourth promised.

For six years it has now been under trial; it is demonstrably stronger than an equal quantity of materials otherwise disposed. The rail is safer, and free from damage: it is not exposed to the same amount of mischievous vibration, and it is not compounded of loose jolting parts. Moreover, it is actually 25 per cent. lower in cost and in maintenance. Public authorities approve it; but the humour of the thing is, that they who should use it profess to be afraid to use any-

thing "which is not in general use." Experience has tested it, and experiment is easy—but inertia is easier.

The wheel—the horse-foot wheel—was shown one day in model to another railway authority, who, if he reads this, may remember the circumstance. He thought it very remarkable, and proposed to have it constructed at ——. The inventor declined, alleging that they could not make it at that establishment.

"Why not?" said the honest and gentlemanly magnate.

"I will not explain why," said the inventor, "but they cannot do it. Give me authority to get it done, and it shall be done!" But he went on his way without the order.

A fortnight after he again saw the magnate.

"Well, I have shown your wheel to ——, and he is going to make some."

"I am obliged to you for your interest," replied the inventor, "but again I tell you that he cannot—or, if you prefer the phrase, will not—make them."

A month after that the magnate again saw the inventor, and informed him that the experiment had been unsuccessful.

But meanwhile a successful experiment was making on another line, where there was a will to succeed.

The public generally is not aware that the railway tyres next preferred to steel are of the iron called Low Moor, the highest priced of all iron. Staffordshire tyres are regarded with contempt, being only two-thirds the price of Low Moor. The horse-foot wheels of the inventor were purposely applied with Staffordshire tyres, and were put in competition with Low Moor tyres running in the same train, and applied in the ordinary manner. The result has been, that the Staffordshire lasted twice the time of the Low Moor. Costing two-thirds of the money, the durability was doubled.

And this was attained with greater absolute safety. The Low Moor tyres were pierced with holes to attach them to the wheels. The Staffordshire had no holes. The Low Moor were strained on hot. The Staffordshire were applied cold. The Low Moor were in tension. The Staffordshire were in a state of rest. The Low Moor sledged on the rails or curves, and produced torsion of the axles. The Staffordshire rolled with less sledging, and having no tension it was impossible they should break even in frost. They were elastic, like a horse's foot.

A neighbour line took heart of grace and applied these spring-tyred wheels to a locomotive engine, with what are called four coupled wheels. These also were Staffordshire tyres, and on driving-wheels the test was harder. For nine months these wheels worked on sharp curves and heavy gradients, till the boiler (being an old engine) became too old for safety.

An accident happened on a line, and it came out in evidence that the leading-wheel tyres of the engine were regularly worn down in two months, so that the flanges became too thin for safety, and the wheel-tyres had to be reduced in diameter about an inch to get up new flanges.

The inventor applied to the engineer to try his horse-foot tyres on the leading wheels of a similar engine working over the same sharp curves and steep gradients. The result proved that the horse-foot had four times the durability of the ordinary wheels.

"How is this to be accounted for?" asked the engineer.

Very simply. The flanges wear by a shearing action against the rails. A pair of shears will not cut metal unless the axis be perfectly firm. The ordinary wheel has the tyre firm, and it is shorn. The horse-foot wheel having an elastic tyre, it yields, and slips aside and will not shear.

An opportunity occurred on a distant line, also of sharp curves and steep gradients, where the tyres were rapidly worn out. Horse-foot tyres were applied to an engine with six wheels by an engineer who believed in the theory. In due time a report came to the following effect to the inventor:—

"Your tyres are going on quite satisfactorily. I had them made of common Staffordshire iron, and put under a six-wheeled coupled engine. They have now done a year's work, and through last winter's frost with heavy trains, and though this line is all heavy gradients, with the sand constantly in use to prevent slips, yet the wear has been very slight. I am so satisfied with them that I shall apply them to every new locomotive."

So the theory of our inventor was demonstrated in practice on three lines with the same results—inferior priced iron doing the work of the most costly—an iron of tough fibre not involving the risk of breakage belonging to the harder irons.

Thus, a rail and wheel exist in the principles of which safety nearly absolute and cost greatly reduced are found at the same time. So our inventor reasonably thought their use should extend.

On application to another engineer, pointing out the theory and fact, the inventor got the following reply: "It is all very true, but I am placed in a position of responsibility, and must protect myself. If an accident happens on my line by a wheel breaking, the jury, prompted by the plaintiff's solicitor, will ask whether I have paid the highest price and used a wheel in common use. If I answer in the affirmative, I am held harmless; but if I have obtained any wheels at a cheaper rate, or used a new system, I shall be condemned for using new-fangled plans, having more regard to the pockets of the shareholders than the public safety."

This is the dead-lock against railway improvement and railway safety.

Conversing with an intelligent gentleman in an official government position, the inventor remarked: "The companies are penny wise and pound foolish. They have a horror of small experiments, and yet notoriously rush into experiments on a large scale on sudden emergencies without any previous trial, under the pressure of public opinion. Were the companies to place at our disposal 10,000*l.* a-year for the purpose of verifying essential improvements by experiment, they would probably save an annual million and avoid a large amount of mechanical accidents."

This would be better than for whole bodies of directors and officers than to pass their lives under a system of indefinite responsibility. At this very time the system of permanent-way in common use in England with a reversible rail in cast-iron chairs with wood keys is disapproved by government officers, and were it now proposed as a new system would not be admitted. In case of an accident from a broken rail, the first question is, "Has it been reversed?"

Logical Sequence.—The primary source of all wear and tear on railways lies in the contact of the wheel and rail. If the wheel-tyre, of an inferior material, can be made to attain three-fold durability, *ergo*, the same effect must take place with the rails. This system, therefore, should have the effect of prolonging the life of the rail to its originally intended duration, twenty years, by reducing the destructive power of a thirty-five ton engine down to twenty tons or less; at the same time rendering derailment much more difficult, while materially lessening the total cost.

W. BRIDGES ADAMS.

THE GREAT EASTERN.

LIKE all new things, much prognostication of failure has been indulged in with regard to this vessel. It is sufficient that she is the largest vessel in the world, for people to find out all the shortcomings possible. But there is one thing, which if she accomplishes, will make up for all possible failures of another kind. If she accomplishes the great fact of enabling bad sailors to cross the ocean without being sea-sick, she will revolutionise sea transit, increasing the amount of travellers in the same proportion as modern railways compared with the old stage coaches. Sea-sickness is induced by the upheaving of the diaphragm in proportion as the rising and falling of the waves converts the vessel into a moving lever, uplifting stem and stern alternately. Yet strange to say, there are people to be found who maintain that the larger the vessel the more she will pitch and roll. They forget that a large log is undisturbed by the ripple on a sheet of water, while a small toy vessel is incessantly moving and tossing, taking every angle of the ripple in its departure from the horizontal line. The question is only one of proportion. If the waves be large, the vessel must be much larger, to prevent any disturbance. But the objectors persist in regarding the waves as solid ridges upon which this long vessel is to rock, forgetting that the weight of the vessel will sink into these ridges till the displacement is sufficient to support her. She will make a straight horizontal course through the waves, while their crests and valleys undulate alongside. If seven hundred feet of length be not enough to

accomplish this, we must go to a thousand, till we have "ruled the waves" straight.

But if she does not pitch she will roll, say the objectors. Possibly, but still it will only prove that she is not large enough. Her size has been calculated from the datum how to carry coal enough to India and back without supplies on the passage. It is only incidentally that her sea-sickness-avoiding capability comes about, and if she be not perfect under the extreme violence of the waves, the next ship will require to be bigger, that is all. But it is only in the South Atlantic where the heavy waves occur. The waves of the Bay of Biscay and North Atlantic are quick and short, those of the South comparatively slower and longer. If her speed be anything near what is talked about she will not roll. Slow movement is essential to rolling.

The next question is, Will she be fast? We don't know. Her great size renders calculation difficult. It is a new circumstance. Speed is to a great extent a question of fuel. She must be very fast to satisfy the expectations of her projectors; but whether she is so or not, a few days, a few hours now will decide. But even if she be not fast, even if her speed is less than that of other vessels, still if she be free from sea-sickness she will monopolise the great bulk of the passengers. They will wait for her time going and returning. And with regard to the allegation that her capacity for cargo would make a glut, the probability is that she would prevent the occurrence of gluts by keeping down the competition of smaller vessels, and making supply a matter of regularity instead of uncertainty.

But supposing all that can be imagined of these defects, inferior speed, and unfittingness for transport of goods, there is yet the use never yet supplied—if only she be free from sea-sickness.

There is a considerable number of persons to whom the sea is a luxury, if not a necessity. There are numerous keepers of yachts, and many more who would keep yachts if their means were sufficient. There is a large class of persons who visit Madeira, and a much larger class who would visit it if possessing money enough—people who need pure air for purposes of health. There is a large class of people who, born and possessing property in England, cannot yet endure the extreme vicissitudes of the English climate. If these persons could live upon the sea they would, instead of living in houses upon the sea-shore with all the disadvantages of impure air.

What are the present drawbacks to dwelling on the sea? Nausea, unquiet movement, limited provisions, unpleasant contiguity, absence of society and land enjoyments, want of exercise, risk of fire, risk of drowning, expense.

Assuming the capital embarked to be 500,000*l.*, 10 per cent. for interest and renewals would be 50,000*l.* a-year, therefore 250 families could live here at a rental of 200*l.* a-year each, say 1000 persons at 50*l.* each, as a floating hotel. For people dwelling on the sea, and not using it as a mere road, no great speed would be needed, and probably one-fourth of the estimated fuel would suffice. The screw might serve without the paddles. With regard to nutriment, the cost would be less at sea than on shore, from the absence of duties and the facility of preservation, and all the operations of domestic service would be reduced in cost. There is no reason why families should not live altogether in private, if desiring it.

The vessel might make a continuous voyage up the Mediterranean and to other warm climates in the winter season of England, and to the North Sea and the coast of Norway in the hot months of summer. The Sea Kings would resume their ancient dominion, making the salt water their home with their wives and families, and with none to make them afraid.

There is no doubt that iron houses on the sea can be built as cheap as brick or stone houses on the land, and as many land expenses are thereby avoided, sea-travelling may be obtained by persons of moderate income, as a means of health, to whom at present it is a costly luxury instead of a cheap necessity. All the conveniences of home, and medical attendance, might exist, instead of the absence of all comfort so frequently experienced in strange countries.

I am not supposing this is to be a necessary result of the Great Eastern, but merely showing that she has a value and uses quite independent of ordinary vessels, that should preclude her from being a loss to the shareholders. But if she be not fast, and not to be made fast, and be free from nausea completely, other and greater ships will be built that will eclipse her; and she would not be a discouragement to other great and valuable speculations if her owners find out a new use for her. Railway engineers and contractors, who have accumulated money, have largely contributed to build her; and probably no country in the world—save England—could have produced her. She is a growth of brains and hands, that time is ripe for as a new investment for capital; and she is emphatically a vessel of *Peace*.

W. BRIDGES ADAMS.

OUR ENGLISH WORLD-WINNERS.

An earnest artist named William Walker, not being wholly absorbed in the pursuit of gain, but working with enthusiasm on his own perceptions of what is great in humanity and fitting in a nation, has for many years devoted himself to the task of gathering and grouping together the great men who were living in the early part of the present century when the great man-preyer, Napoleon Bonaparte, was in the zenith of his power,—the man-preyer who cared for no arts but those conducive nearly or remotely to his war-trade, and who called Englishmen shop-keepers, because he could not plunder their shops at his pleasure,—the man-preyer who would have slain the whole human race, in order to sit on an universal throne.

While he was doing, and trying to do more of these things, the English nation withstood him; and with all that labour upon them, leisure was found amongst them to follow up the peaceful processes by which the world has gradually been won from a wilderness. The works of war they wrought at, unceasingly, in self-defence; but the works of peace went on notwithstanding, to pay the cost of war, and yet heap up a constantly accumulating capital of which the world had never before an example.

When our progenitor Adam left Eden behind him, changing the spontaneous growth of food for that grown by labour, then began the processes by which the brain of man, labouring on from year to year, had to win from nature her hoarded knowledge, and convert her physical forces into the servants of man and the substitutes for his physical strength. And these processes will go on enlarging and improving till the whole habitable world shall become an Eden by the operations of art; and then the drudgery of mere labour shall cease, and that labour only which is exercise of the mental and physical nerves and muscles shall remain. Our chemists and our machinists are the pro-creators of these latter days, destined to achieve the art-creation that shall remove the primal curse, making happiness the normal condition of mankind, and misery only an accident. Before us, by dint of the loving energy and enthusiasm of Mr. Walker, is a picture, not painted for the few, but engraved for the many, of some fifty of the pioneers of this our land, who have led the way in winning from the wilderness this portion of the earth, and setting the fashion to those of other lands to go and do likewise.

This is of a verity a picture of great men—men whose instinct it was to work for the world and fight against misery: some of them wealthy and some of them poor; with visions perchance of wealth to come, but still working for the world's welfare as the only path through which to ensure their own,—the race of path-finders who are ever setting copies for the English nation to work by, and thus gain more results by the development of national energy.

Accompanying the picture, which contains upwards of fifty portraits, some full figures, and some more or less hidden, but all admirably grouped, there is a volume, by Mr. Walker's son, giving a brief memoir of the salient points of each individual history; this also is well executed, and it forms a useful book of reference for those who would know more than the picture can tell.

Philosophers, astronomers, naturalists, and physicians, are put in the group; then follow the chemists, and, lastly, the engineers: this is as it should be,—they who gather knowledge from the stores of Nature build up the groundwork whereon true art is based, and whereby empiricism is corrected.

Prominent in the first group is Herschel, with a

globe by his side, a paper in his hand, and thought in his face, which the keen eye of Maskelyne is watching. Then comes the benevolent face of Jenner; more than benevolent—beneficent, for benevolence is a very easy virtue. Sir Joseph Banks is looking over his shoulder—a starred and belted baronet, genial and pleasant, showing all outward reasons why he was popular at the court of Queen Oberea,—an enterprising man, making voyages to hard and wintry lands, in the pursuit of nature, though rich enough to live at home in quiet, and this, too, in days when ships were veritable "prisons, with a chance"—and more than a chance—"of being drowned," and not the sea-palaces of our modern yachts, in which our modern lords make voyages to Greenland and elsewhere, albeit with none of the ancient valour of our race decreased—as daring as ever—but with the scurvy vanquished by pleasanter food than "saur kraut," and many other confections than the "rob of oranges and lemons."* Brave old Sir Joseph, he was indeed Nature's wild huntsman on untrodden ground, and no carpet knight, cynical Peter Pindar and George the Third notwithstanding.

Seated on a low chair, a volume of large size poised edgewise on his knee, and with his hand resting on it, and his fine abstract face bent down in thought, is Cavendish, the descendant of a long line of nobility, yet so earnest in his chemic art as to be unconscious of any class distinction. Heeding not money or power, or any worldly reward, he was the man who would have pursued his experiment with the last remaining drop of water while the rest of the world was ablaze,—a special agent of Providence to unfold the secrets of nature in furtherance of the process that substitutes the sweat of heated water for the sweat of man's heated muscles.

With spectacles on nose sits Dalton, the man who reduced the world to "atoms," the philosopher of quantities and proportions, but whom rich, and wealthy, and ambitious Manchester—to which he emigrated from Cumberland—left to penury, because his theory could not build up a patent for the better production or dyeing of cotton cloth, or some other visible or tangible article of sale. They are firm brows above his spectacles, but withal the face is stamped with a "Dominie" expression, the result of too early work as teacher in a school ere his mental muscles had acquired distinctive form. It is not good for man to live too much with inferiors or subordinates. Dionysius in his kingdom or his school was equally a precision. But precision is a needful quality of the Quantitative Philosopher dealing in balances of materials, yet needing a balance of another kind when dealing with humanity. The indomitable bearing of the man who lives hard and works hard, seeking no patronage in the process of rising from Weaverdom to a Masterdom in chemistry, is a goodly contemplation. But is there no process by which a man can make sure of being rewarded for a lifelong work till he attains to sixty-seven years, and then of obtaining something better than 150*l.* per annum?

Behind Dalton is Sir Humphry Davy, the great Cornish man, and greater chemist, with the advantage that his pursuit was not abstract, but capable of material demonstration, such as people could understand by vision. The face is small and gentle, but not strong. It may be that he was too early dandled, too early popular, or it may be too material (which is one source of popularity), though his book on "Salmon Fishing" shows a strong love of natural science. The material philosopher must ever be more popular with the crowd than the abstract or moral philosopher—for the more palpable a thing, the greater is the number of the recipients: this may be the reason why Cuvier held his art and science inferior to his title, and why Davy thought a knighthood at the hands of George, Prince Regent, a greater thing than the unfolding of nature's mysteries.

Close to Davy stand Hatchett and Wollaston, the latter famous for his resolving small things into great—a tea-tray into a laboratory; a genial man withal, a philosopher as well as a chemist, and a man of business also, making 30,000*l.* (a huge sum in those days) by teaching how platinum might be forged into bars, though it could not be cast into ingots.

The father of Hatchett was a coach-maker royal, who built vehicles for George the Third. He was a man of shrewdness and of some inventive faculties, but rather curious than useful. He was the first inventor of a suspension wheel, a very different affair from what are now called suspension wheels. The spokes were subtracted, and their place supplied with leathern straps stretching diagonally between the nave and the periphery. These straps were intended to serve as springs. The result was, as might have been expected, a very erratic movement of the peripheries, followed by a break-down.

Mr. Hatchett had also a perception that the lower the centre of gravity in a carriage, the less likely it was to overset. This was a mechanical truth, and he acted on it. The result was a vehicle which obtained the name of a "Spider" from its general configuration. A small body, something like a sedan chair, was hung between four large wheels, the floor being within a foot of the ground. Permission was granted for the inventor to exhibit it to his Majesty George the Third, at Windsor; so down he went thither behind four post-horses. But in those days ruts were very deep and mud was very plentiful, and by the time he arrived at Windsor, the "Spider" was stained and covered with the variation of each soil 'twixt that and Long Acre. The busy king, punctual as ever to an appointment, was there in waiting, and ere Hatchett could get the mop to work, just as he emerged from his muddy cage, there was the well-known repetitive voice, immortalised by Peter Pindar, at work.

"What, Hatchett, Hatchett! all mud, all mud, Hatchett!"

And so the "Spider" was never repeated, though the joke was, as often as the king and the coach-maker met. The "Spider" was stowed away in a corner for its namesakes to build upon.

But Mr. Hatchett throve notwithstanding. He was a tradesman of the time and for the time. He lived over his shop, guiltless of a suburban villa,

* See "Cook's Voyages."

and his wife took care that the chips were not wasted in their early career: she was witty in her way, too, as well as thrifty, for when the future chemist, apprenticed to his father's trade, and up betimes at the bench, was wanted to breakfast, she would put her head out of the back window, and call:

"Now, young Chopstick," a playful paraphrase on the family surname. And he might chop sticks, but like the smith in the nursery tale, who could only make a "hiss out of his hot iron," so the labour of the small Hatchett was nought—no king, or prince, or duke, ever rode behind his unhandy work.

But his father was born before him, and of the thriving class. When he grew rich he built himself a new house, still over his great front shop, with such taste as was in him. A wooden palm-tree supported the brestsummer* below, and there was a square court on the leads of the first floor, with mock windows whitened, to give light to his back front, and to shut out the shops where his men plied their tools. The house itself was a curiosity. There was a breakfast parlour, a complete oval in plan, with door and window to match. And there was a large front room, canvassed and painted all over with classic scenery in dark colours, the doors all concealed, and the spring-door handle made in imitation of an ivy leaf. We believe that the place still exists, looking down into Long Acre, and that it is in the occupation of a bookseller, or bookstorer.

The ruling passion is strong in most men, and the ruling passion of Mr. Hatchett was carriage building. Thus, he built his house like a carriage, without any fixed staircase. While it was building he went in and out by the ladders and folding steps; and when it was finished he found that a staircase was needed, and that there was no space to make it. So he bought a small house in an adjoining back street, and made an unsightly stair, with an entrance door very like that of a watchhouse.

But he had turned the luxury of the wealthy into a save-all for himself, and had accumulated a large fortune, which he left to his only son Charles, who was a chemist, partly from taste and partly that it was a popular and fashionable pursuit. Yet he worked hard at it, and rendered good service, having leisure thereto, and not being driven (like Dalton) to seek a livelihood by his labour. He was not an originator, but a plodding worker, with a rich man's laboratory, in some of the many paths that had been struck out by others.

At the central table opposite to Dalton sits James Watt, worthily representing Chemistry and Mechanism. Midway is Matthew Boulton, a veritable gentleman of the old English stamp, a man of clear perception, without whom Watt would perchance have been doomed to blossom unseen. It is no light thing to conceive a mechanical idea, and to bring that idea forth and cultivate it, and to cause it to grow up into healthy existence. But not the less needful is it to have appreciators of ideas. All the mechanism, all the chemistry of the world would be practically valueless were it not that there is a multitude to perceive and applaud, and to profit by them. All the buttons in the world could not prevent Matthew Boulton from having "a soul above buttons," or from perceiving and hailing greatness wheresoever it might be found. So Watt and Boulton were the Pylades and Orestes of early mechanism, and they needed no Jason to lead them forth on a golden quest. Coal mining and water pumping was the great work of their day, and mechanism and machine mills followed. In both these men is to be seen that union of Celt and Saxon, or Dane, which constitutes an Englishman,—the faculties of perception to generate and perseverance and daring to accomplish.

Close to Boulton sits Marc Isambard Brunel, a Celt full of contrivance at a time when contrivance was not so common as it is now, when the public mind has become cultivated by the wide spread of mechanism. He was a fortunate man, for he fell in with Sir Samuel Bentham, and through him obtained Government employment. The judgment of the man was not equal to his imagination. He was not of the stuff of which Watt was made; but he was of the class of whom it has been said that they can no more help contriving than hens can help laying eggs.

On one occasion, when he had been laid up for several months with some defect in his lower limbs, John Farey called on him. "Take a seat, Mr. Farey," said the invalid. A large chair stood before him, looking as if two men could scarcely lift it, so Mr. Farey put two hands to it with all his strength, when suddenly it went up to his head, and Brunel burst into a violent laugh, prolonged for some time. The chair was a cheat. He had amused himself with pasting strips of paper round an ordinary stick chair, then cutting it off with his penknife and gluing it together, and thickening it till it became a mass of hollow papier maché. Sir Samuel Bentham, had originated this tubular idea many years before, and had all his fire-irons made of thin tubular steel.

Behind Brunel, when he should have been in front as the master mind, stands the mechanist, and more, the ideal and constructive engineer, Sir Samuel Bentham, to whom nothing came amiss, and whose patent specification to this day marks the character of his mind—a specification without drawings, so clear is the wording. A lawyer's son, he had no taste for the law, but, like Peter the Great, went to the Royal Dockyards to study shipbuilding; and so he went on, his moral sense and perception guiding the course of his physical inventions, now machines, now a school, now a prison, and then a factory. He went to Russia, and there executed much military and other work. When he found his light guns kick, and his round shot hop off from stone walls, he backed them up with timber against the cascables, converted all recoil into added force on the shot, and soon made lime and stone fly. And when he came back from Russia to his brother Jeremy's house, in Queen Square, he began to make machinery for all kinds of wood-work before unknown, and planned and built ships for the Admiralty, in which for the first time powder magazines were made safe. The Portsmouth block machinery, called Brunel's, was in reality Bentham's, whose mind took the same logical form in mechanism that the mind of

* Probably from the French, *apprêt-sous-mur*.

his brother Jeremy took in law. But Brunel reaped the pecuniary benefit, such as it was; and Bentham was shelved by the usual Governmental process, going to France, on the return of peace in 1814, in order to bring up his family economically. Pleasant is the modest face of Sir Samuel, in the background, with almost a winning gentleness, like that of his brother Jeremy, who when returning to his home through Tothill Street, dressed in a suit of grey, of ancient cut, and with long grey hair falling over his shoulders, sat down, tired, on a door-step. A lady passing, struck with his appearance, and taking him for a poor man, gave him a penny. He took it, enjoying the jest, and ever after kept it in his writing-desk.

Near Sir Samuel Bentham stands Maudslay, the original Maudslay, who founded the famous firm. He was a huge man, broad and stout, of whom it could not well be said that his mechanical talent lay in a nutshell. On one occasion, while they were busy on the building of the "London Engineer," the first steamer that crossed the Channel, some experiments were making, and Maudslay was wanted. "Go for him," said John Farey to the clerk; "pick out the best coach on the stand,"—there were hackney coaches in those days—"and be sure to load him equally between the four springs, or there will be a break-down." When Maudslay came, and the consultation was over, John Farey was wickedly slow in taking the draught of water. When asked why, he said, "I am waiting till Maudslay steps ashore, she'll rise half a streak then."

Prominently next to Watt stands Rennie, the mechanician, the engineer, the bridge builder, the canal maker, the lighthouse constructor; and earnestly looking up into his face is Telford, his peer, one of the same calibre, a man who could have invented all that Brindley and Smeaton did, had it not been done before. They were men of strength and faculties, who worked with brain and hand, and not by jobbing in shares. Affectionate is the face of Telford; rugged that of Rennie—a strong man, with a large body to match a large head.

In the background stand Count Rumford (such was his Swedish title), and William Murdoch, the economiser of heat for domestic purposes, and the constructor of the first steam locomotive, although only in a model; both have beneficence marked in their faces.

Cartwright and Crompton follow next, the inventors of the power-loom and spinning-mule, which called into so large an existence an exotic trade, removing it from its native India to Lancashire, and furnishing a large portion of the wealth that enabled England to resist the despotism that would otherwise have overwhelmed the Continent, a trade now at the culmination which will again lead it back to India.

Cartwright is an example of the inventor in his highest phase,—the discoverer by forethought, and not the mere contriver by afterthought,—the poet, the minister of religion, and inductive physician, who lived till forty years of age unknowing of mechanism, till the problem was accidentally proposed to him, how to supply weaving hands to answer the demand of the yarn plethora which machinery had induced, in answer to the previous yarn famine, balancing supply and demand.

And so Cartwright—a minister of the church, and not the first or the last with a similar aptitude—set himself to work to produce a machine loom, and gradually completed it in all its parts; and as the customs of society forbade him becoming a manufacturer, some of his friends established a factory at Doncaster, and failed in it, probably from want of business aptitude. Another of his mills was burnt down by the mob at Manchester, who feared loss of employment; and finally Parliament awarded the man who thus marvellously had aided England's prosperity, with a less sum than it had cost him to bring his invention to use. Ere his death he had practically given to his country machine labour equal to 200,000 men. In that thoughtful, earnest face, set before us by Mr. Walker, there are the aspect and lineaments of the philosophic poet stamped by Nature as a benefactor of mankind, a creator and distributor of wealth, too earnest to reserve his own share of it.

Close by him sits Crompton, the farmer-weaver, who learned to work and play in the quaint old building called the Hall-i-the-Wood, who loved music better than weaving, but was constrained to the latter by the necessities of life. With the eight-spindled jenny of Hargreaves he spun his yarn for his own weaving; and, after five years of thought, he produced his spinning-mule with forty-eight spindles, multiplying the power by six, and the excellence of the quality many fold. And all this he had done when only twenty-seven years of age.

Then came his trouble. The manufacturing men who had not the inventive brains, besieged him, and bargained with him to buy his machine, and then cheated him of the payment, giving him little more than sufficient to construct a new machine. Very similar to this was the process which dispossessed Eli Whitney, the inventor of the cotton-gin, of his reward in the United States. The planters broke into his house by night, and stole and published his invention, thus precluding him from obtaining his patent.

The face of Crompton is that of a thoughtful student unused to worldly ways, and rendered cautious by being practised upon. An honest worker, desirous of using his own invention in peace, he was unfitted to struggle with the competitive world about him. After all his struggles, a miserable pittance was awarded to him, by the charity of pitying neighbours, enough to save him from hunger in his old age.

Lord Stanhope is not omitted: he is a man of the Cavendish stamp, but a mechanist instead of a chemist; yet with a mental warp that could not recognise greatness in other things than mechanism—a workman, with an hereditary fortune provided him, a man ill-fitted to the aristocratic sphere of his birth; one like King Louis of France—a good locksmith spoiled to make a weak king. Had Lord Stanhope been born in the sphere of a Brindley, he would probably have achieved far greater things.

In the face of Richard Trevithick there is an expression of the same kind of energy and ambi-

tion that is seen in the portraits of the elder Napoleon. With a genius for mechanics he had also a genius for many other things. The very versatility of his powers precluded his success in life: he was a valiant and gifted Cornishman, with imagination of a high order, but with little self-control.

Like the skeleton at the Egyptian feast stands Joseph Bramah, with his back towards us, his portrait never having been painted, and his bust, modelled by Chantrey, having been destroyed, for what reason appears not, by Lady Chantrey, after the sculptor's death.

Whence came that name, sounding so like Braham? Was it also in its origin an Abraham, and did it come from the Hebrew tribes in York, with its accompanying artist cunning? He, too, was a many-sided mechanist, one who did the world large service, and who, aided by a good business faculty in buying and selling, did himself and his heirs service also. Very like to his nephew, John Joseph Bramah, is that head in shape, ingeniously devised by the artist from the memory of his kindred. John Joseph inherited the business faculty of his uncle, and his love for mechanism, if not his inventive skill. He it was who gathered together in Pimlico a huge business in railway plant, with the aid and help of the two Stephensons, George and Robert, and subsequently transferred it to Smethwick, near Birmingham, as the "London Works," joining with himself Charles Fox and John Henderson as his partners; and out of their works finally grew up the Crystal Palace, the Non-such of its time, which faded away also like the other Non-such in the days of old.

Much did these great men invent, unfolding principles that left to others little else but contrivances to follow in the same track. In these days the growth of machine tools has made possible the construction of great machines which were not before dreamed of. There is no longer any merit in workmanship, for the machine does it all, and imagination comes into play only in design. But the existence of the tools tends also to cramp design, for the design is made subservient to the capacity of the tool. There is another evil, too, now strongly experienced by originators. The race of men with brain, and eye, and skilled hand all in combination, needful to original things, is disappearing, and a wide-spread complaint exists that few skilled workmen are to be had: men are only attendants on automata.

But we are yet far from the ultimate victories of invention,—the fish in the sea are more in number than those taken out of it;—and it is to the small number of model-makers that we must look for the cultivated culmination of their cunning of hand. A long list might be made of things yet to do, in which skilled craftsmen will be needed to set the patterns; and in good time they will come.

Some future artist will yet give us the pictured aspect of more benefactors to society at large, including those rare men who, though not conspicuous by large apparent results, yet do as Hampden did in the cause of freedom—men not great in acts or speech, but prophets constantly suggesting to others the true paths of progress, giving the ideas and planning those processes by which others achieve what is called success—success I mean in the eyes of the multitude, which measures men and their results by the stir and noise which they excite.

Grateful are we to men like Mr. Walker, who has thus gathered together in groups the world's workers, with their images and superscriptions, that men may know their benefactors and render to their memory that justice which was too rarely accorded in their lives.

So, all honour to the work of both the father and the son, the picture and the book, in teaching the men of the present what they owe to men of the past. W. BRIDGES ADAMS.

THE GATEWAYS OF ENGLAND AND FRANCE.

Men, my brothers, men the workers, ever making something new,
That which they have done but earnest of the things that they shall do.

MIND is related to matter, much as a sword is to its scabbard; without matter mind has no dwelling-place, and human beings, like plants, are constituted relatively to the locality they inhabit, the original types being modified by circumstances. And thus grew up in the world the various races of Englishmen and Frenchmen, Germans, and Spaniards, white, black, red, and yellow men, some partaking of the nature of the patient ox, and others of that of the ferocious tiger. Some again have high faculties of a god-like type, and others are mere animals. Some are rulers and lawgivers from their birth, and others are born only to obey, or to be coerced. In all countries men are to be found of the higher type, but

unquestionably the temperate zones, with favourable circumstances and localities, produce the highest, and in the greatest numbers; and one great purpose they serve in creation is to furnish just lawgivers and rulers to the tropics and torrid zones, where passion is usually stronger than reason.

Amongst the nations of the world England has upon the whole played a very large part. She has produced a race of men certainly not inferior to any on the earth in physical energy or mental power, and she has produced them in large quantities. These islands were too valuable an abiding-place for inferior men, and one race pushed out another, till the strongest obtained possession, and welcomed amongst them all the best of their continental neighbours who might be seeking for a home. Soil and climate did their work in joining them together and changing them into Englishmen, sloughing off the weakly and assimilating the strong. Coal and iron did much for them, but the climate, varying enough for health, but without extreme heat or cold, did more; for it enabled men to be born and bred to live a long life, and do more days' work in every year of that life than most other nations. A healthy people in a healthy climate, with a circumscribed space for growing food, can only increase their numbers by producing something to sell to others in exchange for food. By dint of coal and iron, and brains, and hands, and arms given to manufactures, thirty millions of people exist where, without them, only half the number could be maintained in health. It is quite true that the fifteen millions might dwell together quite as happily without the manufactures, and with quite as healthy a climate, and, on the whole, a healthier population. But there is another and more important consideration. With only fifteen millions of people we could not furnish emigrants to colonies for allied friends, and we could not maintain fleets and armies to keep off despotic invaders who would strive to break down "the home of the free." That channel, called by us in the olden time the Narrow Sea, and by the French the "Sleeve," might be crossed by numerous invaders, and our island of long memories might become an appanage of a continental ruler, while the best of the race would go forth to populate other lands.

Those who profess to be learned in coal,* say that we are fast destroying a substance which we cannot reproduce. This, after all, is but conjecture. They say that there may be coal below a depth of four thousand feet, but that it will be too costly to be worth getting. There was a time when the same class of men argued that it was impossible to provide for our surplus population by emigration, on account of the great cost of transit, but each succeeding year reduced the cost, and now emigrants can go and return where formerly they could not go. So is it with mining and other labour. Every year adds to facilities and diminishes cost. Every succeeding year beholds more work done with less human drudgery, and the time will come that drudgery will be extinct. But, allowing that English coal becomes extinct, it by no means follows that we cannot import coal from other countries to the healthiest working climate in the world, and yet compete on favourable terms with the manufactures of other countries. And it is by no means certain that other sources of heat-power do not exist within man's reach. We are far from having solved the mysteries of the production of petroleum, a substance known in all time all over the earth, but only of late commanding general attention by proving to be a great source of wealth, competing with coal for various purposes. All the processes of nature in the general economy of the world, are destruction and reproduction: *i. e.*, change of form, as we see in plants and animals, the dying changing into the living; and it is not difficult to imagine that chemical processes may be at work below the earth's surface destroying or disintegrating fuel on one side, and reproducing it on the other. We do not *know* the causes of volcanic action, and can only assume them; but it is clear that fuel of some kind is produced to feed the volcanoes and that huge forces are thus developed. The gases, thus set free, mingle with the atmosphere; but we know not how many processes may be at work restoring them to the interior of the earth to go again through the same routine, as constant as the evaporation from the sea and the fall of streams from the mountains. Had Etna or Vesuvius been situated in the Scilly Islands, it is possible that we should have devised means of utilising their heat-power for many purposes.

But supposing our fuel now existing to disappear, and with it our means of purchasing food and necessaries for fifteen millions of people, we should certainly turn our attention to improved means of doubling our own food production; and this is a vein far from worked out. If we must be reduced in numbers, England will become a picturesque country, more filled with beautiful ruins than any other; but if ambition survives amongst her neighbours, they will not leave her to be a nursing mother of freedom. Like other countries with their monuments in ruins, she

* Sir William Armstrong and Mr. Jevons.

will become an appanage of despots, though too small to become a haunt of their correlative brigands. But, if France should grow up into a land of freedom and justice, it is possible that we may be linked closer together, and future geography books describe London as the chief town of France, the capital of philosophy and laws, the abode of learned ease, the great residence of the world's thinkers.

The sea that runs between France and England has been one great cause of our growth and prosperity. It has been our fence, our barrier, our fortification, our police to keep out continental bandits. Had England remained as a French peninsula we should have been a continental people overrun by soldiers and living under military despotism, a condition not favourable to progress. Just as an enclosed farm is essential to agriculture, so is an enclosed country essential to the growth of freedom and progression.

And now another phase is arising, and men's minds are turned to devising the best means of facilitating transit between England and France—how to make England as much as possible a peninsula. There can be no doubt that sea-sickness, or the dislike of it, is the one great impediment to constant transit, and that, were there a land transit, there would be incessant travel. And, considering that the greatest depth of the channel is only about one hundred and seventy feet, or less than half the height of St. Paul's Cathedral, and that only for a portion of the twenty miles' total distance, there is no insurmountable engineering difficulty in making a dike of sufficient height and width from side to side to carry an ample roadway, always supposing that the money were forthcoming, and that it were commercially worth doing.

Geologists tell us that England was once a peninsula of France. Some convulsion, possibly an earthquake, cut through the chalk rock, and the constant rush of the tides in two opposite directions has since kept it open. The tides wash the shingle along the coasts and form banks in various places. If, therefore, a row of piles were planted on the bottom across the narrowest part of the Channel, sand and shingle would collect to the level of their tops and form a weir, which might be continually raised by additional piles, until it rose above water, and presented to the view a pair of beaches looking up and down Channel. This is on the supposition that it were worth doing. It would be simply a larger work of the same nature as Plymouth breakwater. By a similar process, and at much less cost, the Island of Ceylon might be connected with the continent of India. But it would not be desirable to make England a peninsula of France, even for the sake of transit without sea-sickness. The loss would be greater than the gain to the web-footed race that come over the "gannets' bath," though a very desirable causeway to the "Belles Poules," the Gallic birds, who might wish to come in too great numbers. We do not desire to see English capital employed on a causeway to the Continent; nor do we think it likely that France alone will project her coast-line sufficiently to annex us.

Another plan proposed is to form a tunnel under the water, between Dover and Gris Nes. So far as borings have demonstrated, the chalk rock extends over the whole channel, from one side to the other, and the work is simple when compared with piercing the granite tunnel through the Alps. Only the air-shafts through 170 feet of water, and towering up 100 feet above it, would form any difficulty; that accomplished,—and it would be something more than an Eddystone Lighthouse,—the boring would probably be proceeded with at the rate of two feet per hour, provided the material could be taken away fast enough, which does not seem difficult, as it could be thrown into the sea above; but even then it would be a ten years' labour. The process of boring would be by the power of compressed air, and the pneumatic system would probably be adopted for the haulage of railway-trains. But the tunnel would require lining, as well as boring, to keep out the filtration of sea-water. It is possible that by chemical means the solid chalk might be converted into a kind of hard limestone; but it would also require lining with some substance not brittle, to prevent cracking by vibration. We happen to be out of the direct line of earthquakes, but not beyond their vibratory influence, and a crack admitting superincumbent water, in however small quantities, would ever go on enlarging by the process that forms caverns in limestone regions. It would be needful to form a tough core, probably a wrought-iron tube of sufficient thickness; and this, cased in cement in and out, would probably be chemically and mechanically durable. But two tunnels would be needed, side by side, for up and down trains, or if a single tunnel were adopted, it must be large. There is the contingency of faults in the continuity of the chalk such as we see in all chalk cuttings; but this is not an insuperable difficulty, and the thing could, no doubt, be done, and will be done if it can be demonstrated that a sufficient number of passengers at a sufficiently high rate of payment, having the fear of sea-sickness before their eyes, can be found to make daily use of it, so as to pay a good interest on the outlay. And so strong is human love of speculation in the possible, and the possible profit, that the chances are in

favour of its being done. And it would be an easily defended outwork by drowning it instead of destroying it.

Bridges, with piers in the Channel, have also been proposed, and no doubt they are within the bounds of engineering possibility; but they would amount to a prohibition of large sailing-vessels up and down the Channel, and a considerable risk to steamers—artificial rocks whereon to be cast away; they are the least probable of any process, more costly than a tunnel, and involving greater risk in use.

There are two other methods: the balloon—which might answer for special excursions, but not for traffic, on account of the uncertainty of the arrival—and the old-fashioned existing method of the sea surface. Our choice lies, therefore, on three methods, over the sea, under the sea, and on the sea.

The latter has been very much neglected. It has not kept pace with other things, or long ere this the Channel would have been a mere ferry as regarded travel between France and England. We have made big ships for distant voyages, forgetting altogether that it is the short traffic that pays best. The chief reason for the difference between England and Ireland lies in the sea-sickness that most passengers undergo more or less.

Some persons are not liable to sea-sickness; but they are very few; as a rule, we may take it for granted that all are liable to it. Our greatest sea-captains, the Nelsons and Cochranes, were constantly liable to it, and it is a greater nuisance for a short ferry than for a long sea voyage. If people were sea-sick on the Thames, passage-boats would not be used; if people were not sea-sick on crossing the Channel there would be an incessant transit. Now sea-sickness is merely a question of waves, and waves cease to be perceptible when overlaid with a sufficiently large float. The Great Eastern steamship, with a length of about 700 feet, is not large enough altogether to prevent rolling and pitching in the waves of the Atlantic; but the waves of the Channel are much smaller, and if overlaid with a vessel twice the length of the Great Eastern—a quarter of a mile—like the Charing Cross bridge—such a vessel would make perfectly smooth water, and if double-ended, with efficient piers on either shore, might make the transit each way in an hour, and with no risk of being run down day or night. In fact, she might be a floating lighthouse; and by reason of her large size, might be of very shallow draught, and with the piers sufficiently far out might perform her work at all periods of the tide, with railway-trains on her deck, and ample room for passengers and merchandise besides. A new kind of traffic other than railway transit would commence. Pedestrians or promenaders would pay their shilling or sixpence on either side to walk on board and walk out as they do between London and Gravesend, only with far greater and more certain profit to the ship owners, as there would be no lines of competing railways. Such a vessel, properly constructed in cells, would be absolutely unsinkable and unburnable, and she would not long be the only one, for the result would gradually be the growth of two enormous cities on either side the Channel. That they have not hitherto grown up has simply been the limited traffic in passengers by reason of sea-sickness, and the almost total absence of commerce. With gigantic ferry-boats, the passenger traffic will be as that between London and Brighton, and the commerce as that between Liverpool and New York. They will be the gateways of the whole Continent, the meeting grounds of the nations, healthier localities than either London or Paris, possibly adding to the health of London by lessening its population. And the people on either side the water will gradually grow as like each other as the inhabitants of London and Southwark, and freedom will permeate as from a centre in radial lines throughout Europe. It will be a marvellous result that will follow on the building of the first pair of steam-ships that shall enable us to cross the "Narrow Sea" as steadily as on firm land by the proper uses of our coal and iron, and shall yet ensure us isolation at pleasure from those who might love oppression better than justice.

W. Bridges Adams.

THE DEVELOPMENT OF HUMAN FOOD.

The preparation of food is of two kind public and private. The public consists in ordinary modes of converting minerals and g into vegetables, and vegetables into animals milk, cream, cheese, flesh meat, and marr bones. The private modes are the chemical mechanical conversion of materials by artifi as opposed to natural processes, and they are private as far as possible, because the publi strong in the belief that natural food is wh some, and artificial food unwholesome. This or may not be.

Scents and flavours are notoriously artificial, well as wines; and the public, in these c blinks the matter, because the natural quant are insufficient to supply the demand, and the g mass of the public must either accept the artifi or go without.

Natural food, either vegetable or animal, is ject to decomposition. To preserve it from composition four methods are used. It is char with antiseptics, as salt or sugar; or it is dri or it is hermetically sealed in metal cases, to clude the air; or it is kept in antiseptic g which exclude oxygen. When decompos has commenced, it ceases to be food in law, an denounced as poisonous to human beings, th given to animals to feed on, which animals some cases, are used for human food wh slaughtered, making the poison second-hand.

Diseased animals are also denounced, but does not follow that disease always destroys utility of the food, for the artificial liver compl of Strasbourg geese is even held to produ luxury. How far chemists might or do deal w diseased or decomposed vegetables or flesh we not know, and they would be the last persons tell us, because it would prejudice the sale; but do know that decomposing flesh may, by the of charcoal, be freed from its putrid odour; yet, in the case of game, the odour of decompo tion is carefully sought, and is thought to heigh the flavour.

The process of decomposition, in the case fish, is arrested by ice, which robs it of its flavo

nd in Russia provisions of all kinds are frozen to reserve them. It is clear that the chemical conditions of food vary, for while venison, hares, partridges, grouse, as also some cheese, &c., are held to be most relishing and nutritious in a state of partial decomposition—beef, mutton, veal, pork, and fish are detestable on the slightest approach of putridity, though there is an incipient decomposition, making the two former tender, which renders them better for digestion.

If chemistry can make the putrid fish of Billingsgate and the putrid flesh of Newgate and Leadenhall Markets wholesome, by neutralising the poisonous qualities, it seems desirable that it should be a lawful process. It is possible that such damaged provisions might be chemically decomposed and the putridity or disease got rid of, and if so, there would certainly be a desirability of making the process common.

There is much talk of the adulteration of food; if by adulteration we mean deterioration, that clearly is a thing to be denounced as a cheating process of selling one thing for another fraudulently. But the mixing or changing food with the knowledge of the customer, substituting the artificial for the natural, may occasionally be beneficial.

Amongst the most nutritive articles of our food are milk, cream, butter, and cheese. There is scarcely any limit to the demand for them, and any process which can increase their quantity without diminishing their quality is desirable. Genuine milk is so desirable that at one time a practice obtained of driving cows to Londoners' doors, and milking them then and there. But this by no means proved anything more than that the fluid came direct from the cow. The fact that cabbage leaves and pump water in any quantity were made to pass through a living machine, by no means constituted the chemical substance called milk—the juices of rich grass transmuted.

Cream is a very delicious food, yet it is only the fatty substance of the cow with a peculiar flavour superadded. If our chemists can take the whole fat of the cow after slaughter, and add to it an artificial flavour, and thus convert it into an artificial cream, it will surely be a great gain. There is little doubt that a large amount of London butter is manufactured artificially, but the objection is, that it is a very bad and unpleasant imitation of natural butter.

The present writer was riding behind an engine on a railway a short time back, when there stole on him a strong odour of red herring.

"Why, guard! is the driver cooking his breakfast at the fire-box door?"

"No, sir! that is where it comes from," pointing to a huge factory on the left of the road.

"What are they doing there?"

"Melting down fat."

"For the candle-makers?"

"No, sir; for Dutch butter!"

"What fat is it?"

"Oh! they pretend it's all 'flares;' but they put in old grease of any kind—old railway grease and bone-fat!"

"But why for Dutch butter?"

"Because they can't make it into butter here, as Dr. Letheby and Dr. Hassall would be down upon them. So they send the fat over to Holland ready melted, and make it into butter there, and send it back here, when nobody can say anything against it. But, sir, I'm told that they use arsenic in purifying the fat, and if they don't get it all out before they make butter of it, all the worse for the poor who eat it."

If the English manufacturers produce edible and nourishing fat from waste and other material, and Dutch chemists so flavour it that it tastes like butter, and the effect on digestion is the same, there is no apparent harm in the process.

But it would be well, nevertheless, that it should pass through the crucible of English chemists before passing into the stomachs of the English poor. W. BRIDGES ADAMS.